Tribhuvan University
Institute of Science and Technology

Teaching Manual for B.Sc.CSIT Phy-156 Course

This manual deals with the depth and reference of each topic covered in PHY-156 course. The course is broadly divided into three units, which are extensively used in Computer Science. The course aims at providing fundamental concepts needed to understand information processing and related devices.

Textbook to be followed:

1. Murugeshan R. and Kiruthiga Shivaprasath, Modern Physics – 13th Multicolour Edition, S.Chand and Company, India, 2007
2. Kittel C., Introduction to Solid State Physics, 5th, 6th, or 7th edition, John Wiley

Unit 1: Statistical Physics

Unit	Heading	Details	References/ Murugeshan
1.1	Macroscopic and Microscopic Description of thermodynamic systems, Ensemble and phase space	Microscopic description, momentum and coordinates, Phase Space, Phase space of a 1-D Harmonic Oscillator; ensemble, micro canonical, canonical and grand canonical ensemble, time averaging and ensemble averaging *Numerical examples from the book.*	Ch. 75.1,2; 76.1,2 The description of phase space is detailed with the example of a harmonic oscillator.
1.2 1.3	Thermodynamic Probability, Fundamental Postulates of Statistical Mechanics, Entropy and probability, Boltzmann theorem, Statistical Equilibrium.	Probability and thermodynamic Probability, entropy and probability, Boltzmann theorem, fundamental postulates of statistical mechanics, equilibrium. *Numerical examples from the book.*	Ch. 76.3,4,5,6,7 The description of different ensemble should be detailed. Otherwise follow Murugeshan.
1.4	Maxwell-Boltzmann distribution for ideal gases	Maxwell-Boltzmann distribution [no derivation required, but students should understand the meaning of each quantity in the formula $n_i = g_i \exp(-\propto-E_i/kT)$ and should be able to use it.] *Numerical examples from the book.*	Ch. 75.3,4 Explain the molecular energies in an ideal gas
1.5.1	Bose-Einstein distribution law	Bose-Einstein distribution [derivation not required, but students should understand the meaning of each quantity in the formula $n_i = g_i/(\exp(\propto + E_i/kT) – 1)$ and should be able to use it.] *Numerical examples from the book.*	Ch. 75.5
1.5.2	Fermi-Dirac distribution law	Fermi-Dirac distribution [derivation not required, but students should understand the meaning of each quantity in the formula $n_i = g_i/(\exp((E_i – E_f) / kT) + 1)$ and should be able to use it.] Compare the three distribution laws. Consider electron gas and degenerate and nondegenerate ensembles. *Numerical examples from the book.*	Ch. 75.6,7, 76.9 – 10 Students should clearly understand the distinction between classical and quantum particles and also between Bose and Fermi particles.

Unit 2: Modern Physics

Unit	Heading	Details	Reference
2.1.1, 2.1.2	Wave- particle duality, de Broglie waves, phase and group velocity, Heisenberg Uncertainty principle	Derivation of expressions for phase and group velocities and of uncertainty principle is not required. Students should understand the physics behind these expressions and should be able to use them in concrete problems. *Numerical examples from the book.*	Ch. 11.1,2,3,4 Examples given and numerical problems
2.1.3	Postulates of Quantum Mechanics	Postulate about dynamic variables, about eigen value of operators and about expectation value; Schrodinger equation, explain Hamiltonian (total energy) and the meaning of wave function, probability and normalization. *Numerical examples from the book.*	Ch. 11.7,8,9 Examples given and numerical problems.
2.1.4	Simple applications of Schrodinger equation	Consider the following cases: particle in a box, infinite potential well, potential step, square potential well and barrier, barrier penetration, linear harmonic oscillator (do not derive Hermite polynomials), hydrogen atoms (do not solve the equation but get the energy levels) and rigid rotators (do not solve the equation but find the energy levels). *Numerical examples from the book.*	Ch. 11.10,11,12,13,14,15 Examples given and numerical problems
2.2.1	Crystalline structure of solids, Bravais lattice, Miller indices, reciprocal lattice	Review ionic, covalent, metallic and van der Waals bonding, explain crystal structure and methods to determine unit cell and Bravais lattice, Miller indices, introduce the concept of reciprocal lattice and lattice vectors, Bragg's law for the reciprocal lattice, Brillouin zone, reciprocal lattices of simple cubic, bcc and fcc lattices. *Numerical examples from the book.*	Ch. 41.1-6, 41.9, 77.1-9, 46.1-8 Also consult C. Kittel -Introduction to Solid State Physics (5th, 6th or 7th edition) Examples given and numerical problems
2.2.2 2.2.3	Band theory of solids, Origin of bands Classification of solids: Conductor, insulator and semiconductors	Bloch's theorem, Kronig-Penney model and origin of bands, classification of solids, effective mass of electrons. *Numerical examples from the book.*	Ch. 46.14-17 Also consult C. Kittel -Introduction to Solid State Physics (5th, 6th or 7th edition)
2.2.4	Free electron theory of metals, thermoionic emission, Schottkey effect, contact potential	Sommerfeld model, Fermi energy and electrical conductivity of metals Free electron gas in one and three dimensions, energy levels, Derive $J_e = (\text{const})\, e^{-W/kT}$ for thermoionic emission. Derive the value of contact potential $\varphi = (-2\pi ne / \varepsilon)x^2$ *Numerical examples from the book.*	Ch. 52.1-3, 53.1-2 Also consult C. Kittel -Introduction to Solid State Physics (5th, 6th or 7th edition) for thermoionic emission and Schottkey barrier

Unit 3: Semiconductors

Unit	Heading	Details	Reference
3.1	Band structure of semiconductors	Valence and conduction bands and energy gap *Numerical examples from the book.*	C. Kittel -Introduction to Solid State Physics (5th, 6th or 7th edition)
3.2 3.3	Electron and holes, electrical conduction in semiconductors, effective mass, intrinsic and extrinsic semiconductors, n- and p- type semiconductors, carrier concentration, mobility	Electron and holes, Fermi level, n- and p- type semiconductors, electron and hole concentrations in intrinsic and extrinsic semiconductors, effective mass of electrons and holes, electrical conductivity, derive expression for J_n and J_p *Numerical examples from the book.*	Ch. 55.1-6 Also consult C. Kittel -Introduction to Solid State Physics (5th, 6th or 7th edition)
3.4	p-n Junction	Formation of a junction diode and biasing, carrier generation and recombination (qualitative description only), width of depletion layer and potential barrier height (qualitative), derivation of V-I equation for p-n junction *Numerical examples from the book.*	Ch:58.1-2, 55.7, 55.9-10 Also consult C. Kittel -Introduction to Solid State Physics (5th, 6th or 7th edition)
3.5	Metal-semiconductor junction, Schottkey junction, Ohmic contact	Metal-semiconductor junction, Schottkey junction, Ohmic contact *Numerical examples from the book.*	Ch. 55.15-16 Also consult C. Kittel -Introduction to Solid State Physics (5th, 6th or 7th edition)